United States Patent [19]

Igarashi

[11] **3,820,045**

[45] **June 25, 1974**

[54] **DOUBLE-TUNED CIRCUIT DEVICE**

[75] Inventor: **Sadao Igarashi,** Tokyo, Japan

[73] Assignee: **Alps Electric Co., Ltd.,** Tokyo, Japan

[22] Filed: **Sept. 26, 1973**

[21] Appl. No.: **401,054**

[30] **Foreign Application Priority Data**

Nov. 20, 1972 Japan 47-133687

[52] **U.S. Cl.** ..... **333/70 S,** 333/73 R, 334/74, 336/75

[51] **Int. Cl.** **H03h 9/00,** H01f 21/02

[58] **Field of Search** ..... 336/131, 130, 136, 75; 333/70 S, 73 R, 82 R, 82 B; 334/66, 70, 74, 75

[56] **References Cited**

UNITED STATES PATENTS

2,388,295	11/1945	Shea	336/75
3,593,245	4/1969	Iwata	336/131 X

FOREIGN PATENTS OR APPLICATIONS

580,782	0/1946	Great Britain	336/131

Primary Examiner—Thomas J. Kozma

[57] **ABSTRACT**

A double-tuned circuit device includes a housing, an input lead and an output lead, and a base plate having a conductive surface which is adopted to be received within the housing. A pair of resonator units are separately mounted on the base plate. Each of the units comprises a helical coil having a first end and a second end with a tap therebetween. An insulating cylinder is situated within the coil and mounted on the plate. A rod is movably received within the cylinder to permit adjustment of the resonant frequency of the unit. The tap of each of the units is connected to a different one of the leads and the first ends of each of the coils is connected to the conductive surface of the base plate. Means for adjusting the electromagnetic coupling coefficient of the units is provided comprising a third insulating cylinder mounted on the base plate between the units and a third rod movably received therein.

4 Claims, 3 Drawing Figures

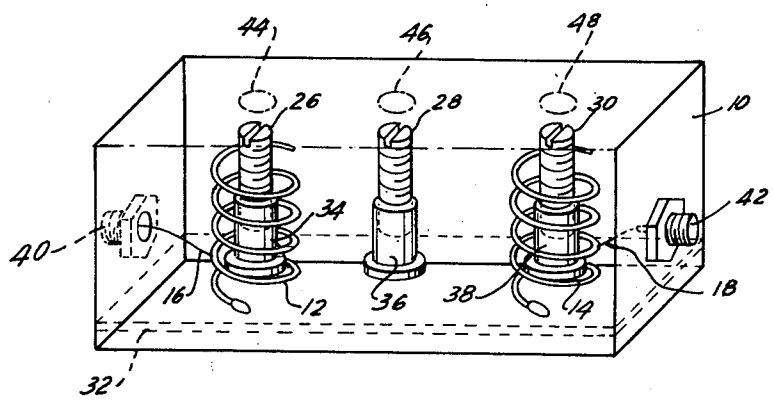


FIG. 1 PRIOR ART

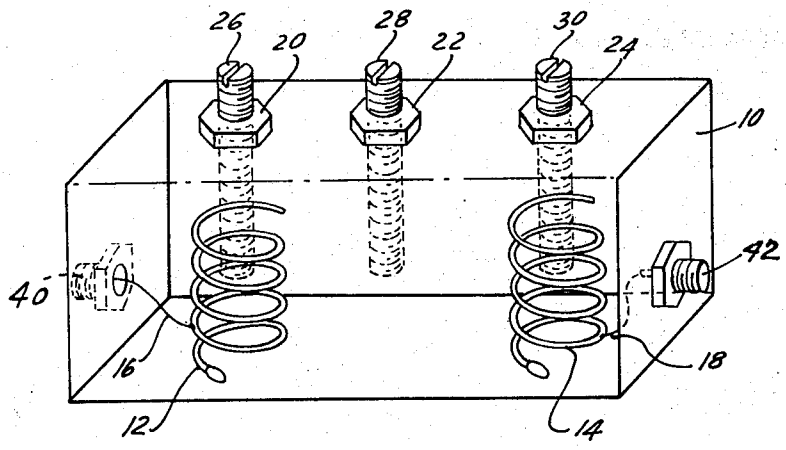


FIG. 2

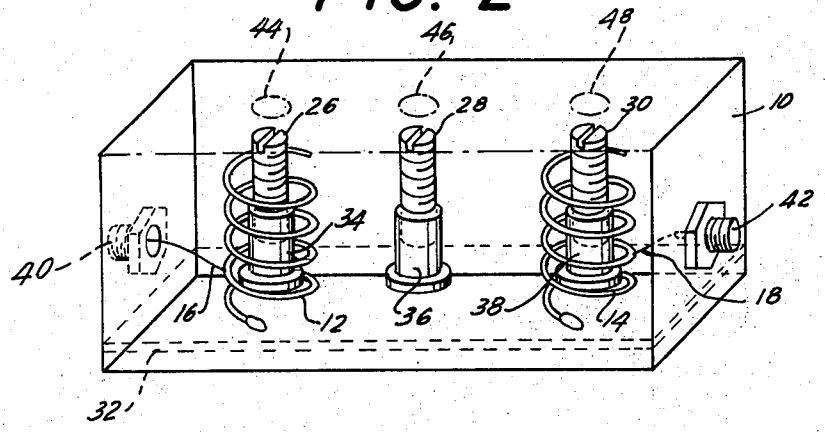
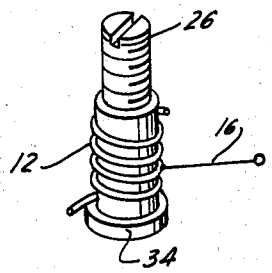


FIG. 3



DOUBLE-TUNED CIRCUIT DEVICE

The present invention relates to double-tuned circuit devices and particularly to a double-tuned circuit device with enhanced stability which is suitable for use as a bandpass filter in the VHF and UHF frequency ranges.

Double-tuned circuit devices consisting of a pair of helical resonator units mounted in a common housing are extensively used in the electronics industry as bandpass filters, particularly in the UHF and VHF frequency ranges. The electrical characteristics of these devices depend not only on the resonant frequency of each of the units but also upon the electromagnetic cross-coupling between the units. The magnitude of the cross-coupling between the resonator units, termed the electromagnetic coupling coefficient, can be varied to change the electrical properties of the device to adopt the device for a specific application.

Each of the resonator units comprises a helical coil into the interior of which a nonmagnetic rod is movably received. The degree of insertion of the rod into the interior of the coil determines the resonant frequency of the unit. Conventional devices of this type have employed externally threaded rods which are mounted to the housing in axial alignment with the core of the coil by means of a nut which is situated on one side of the housing. A portion of the rod extends beyond the nut exterior to the housing such that the rod may be rotated to axially move it and therefore vary the degree of insertion of the rod within the coil.

Adjustment of the electromagnetic coupling coefficient between the units is accomplished in a similar manner. A third nut and rod assembly is situated between the resonator units. The degree to which the rod is inserted between the units determines the electromagnetic coupling coefficient therebetween. Again, the nut is situated on one side of the housing and the externally threaded rod extends outside the housing to permit rotation thereof. The rotation of the rod axially moves the rod to vary the degree of insertion of the rod between the coils.

The prior art configuration has proven unsatisfactory in a number of ways. The threaded rod and nut combination is mechanically unsatisfactory because vibration of the housing may cause the rods to move slightly with respect to the units in which they are situated. This causes a fluctuation of the resonant frequencies of the coils and of the electromagnetic coupling coefficient thereby changing the electrical characteristics of the device. Further, a portion of the rods and the nuts extends outside the housing permitting accidental contact with other circuit components. Moreover, with this configuration, assembly of the device, and particularly the attachment of the resonator units, is difficult and therefore expensive.

It is, therefore, a prime object of the present invention to provide a double-tuned circuit device wherein the rods for adjusting the resonant frequency of the units and the electromagnetic coupling coefficient between the units are mounted in such a way as to provide mechanical stability and therefore prevent fluctuation of the electrical properties of the device.

It is another object of the present invention to provide a double-tuned circuit device wherein none of the elements extend beyond the housing of the device but

in which easy access is provided for the adjustment of the rods.

It is still another object of the present invention to provide a double-tuned circuit device which is easily and inexpensively assembled.

In accordance with the present invention a double-tuned circuit device is provided having a metal housing, an input and an output lead, and a base plate having a conductive surface and being adopted to be received within the housing. A pair of resonator units are mounted on the plate. Each of the units includes a helical coil having a first end and a second end with a tap therebetween. An insulating cylinder situated within the coil and mounted on the base is provided with a rod movably received therein. The tap of each of the coils is connected to a different one of the leads and the first ends of each of the coils is connected to the conductive surface of the plate. Means for adjusting the electromagnetic coupling coefficient between the units is provided comprising a third insulating cylinder mounted on the base between the units and a third rod movably received therein.

The present invention eliminates the disadvantages of the prior art devices by mounting the rods within insulating cylinders which are affixed to a base plate. This provides the mechanical stability lacking in conventional devices. The coils are mounted on the base plate such that during assembly the base plate, including the resonator units is merely inserted into the housing. Access holes are provided in the top of the housing in alignment with each of the rods such that a tool may be inserted therein to adjust the axial position of the rods. In this way, none of the elements extend beyond the housing and are therefore protected from accidental contact with other circuit components. Since the cylinders, rods and coils are all mounted on the base plate prior to insertion into the housing, the device is easily and quickly assembled thus minimizing manufacturing costs.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to a double-tuned circuit device as defined in the appended claims and as described in the specification, taken together with the accompanying drawings wherein like numerals refer to like parts and in which:

FIG. **1** is a schematic perspective view of a typical double-tuned circuit device of the prior art;

FIG. **2** is a schematic perspective view of a preferred embodiment of the present invention; and

FIG. **3** is a perspective view of a resonator unit of the present invention wherein the insulating cylinder is used as a bobbin for the resonator coil.

FIG. **1** shows a conventional double-tuned circuit device employing two helical resonator units which is widely employed as a bandpass filter in the UHF and VHF frequency ranges. The device consists of a metal housing **10** into which a pair of helical coils **12** and **14** are separately mounted to the bottom side thereof. Each of the coils has a first and a second end, the first end being electrically connected to the bottom side of housing **10.** Between the ends of each of the coils is situated a tap. The tap of coil **12** is connected to input connecting member **40** by means of input lead **16** and the tap of coil **14** is connected to output connecting member **42** by means of output lead **18.** Three nuts **20, 22** and **24** are situated on the top side of housing **10.**

Nut 20 is aligned with the core of coil 12. Likewise, nut 24 is aligned with the core of coil 14. Nut 22 is situated between nuts 20 and 24. Externally threaded rods 26, 28 and 30 are received within nuts 20, 22 and 24, respectively. Each of the rods extends outwardly from both surfaces of the top side of housing 10. The external tip of each of the rods is provided with a groove such that a tool may be used to rotate the rod thus altering the axial position thereof.

The axial movement of rods 26 and 30 serve to adjust the resonant frequency of coils 12 and 14 respectively. The axial movement of rod 28 serves to adjust the electromagnetic coupling coefficient between coils 12 and 14. Thus, by setting the degree of insertion of rods 26, 28 and 30 within housing 10, the electrical characteristics of the double-tuned circuit device can be established. Axial movement of any or all of the rods changes the electrical characteristics of the device thus permitting the device to be adjusted to perform a specific application.

As mentioned above, the drawbacks of this conventional configuration are that the rod settings tend to be unstable when vibrations are present thus causing changes in the resonant frequencies of the coils and the coupling coefficient between the coils. Further, since the rods extend outside the housing, they are prone to accidentally contact other circuit components thus causing malfunction of the device. Moreover, since each individual element in the device must be assembled separately, manufacturing costs are relatively high.

FIG. 2 shows the device of the present invention which eliminates the aforementioned disadvantages. In the configuration shown in FIG. 2, the coils and rods are mounted on a base plate or substrate 32 which has a conductive surface to which the first ends of coils 12 and 14 are electrically connected. Insulating cylinders 34, 36 and 38, preferably made of a synthetic resin such as "Styrol" are mounted on the surface of plate 32. Coil 12 is placed around cylinder 34. Likewise, coil 14 is placed around cylinder 38. Externally threaded rods 26, 28 and 30 are movably received within cylinders 34, 36 and 38, respectively. Since the cylinders are internally threaded, the rods may be axially moved with respect to the coils by rotation thereof. The axial position of rod 26 with respect to cylinder 34 determines the resonant frequency of coil 12. The axial position of rod 30 within cylinder 38 determines the resonant frequency of coil 14. The axial position of rod 28 within coil 36 determines the electromagnetic coupling coefficient between coils 12 and 14.

The coils, cylinders and rods are mounted on base plate 32 and then the entire assembly is inserted into housing 10. The tap of coil 12 is connected to input lead 16 which in turn is connected to input connecting member 40. Likewise, the tap of coil 14 is connected to output lead 18 which in turn is connected to output connecting member 42. Input connecting member 40 and output connecting member 42 provide a means for electrically connecting the double-tuned circuit device into the electrical circuit into which it is to be used.

A plurality of access holes 44, 46 and 48 are provided on the top side of housing 10. Each of the holes 44, 46 and 48 is aligned with the top surface of rods 26, 28 and 30, respectively. The top of each of the rods is provided with a groove such that a tool may be inserted into the access hole aligned therewith to rotate the rod. Rotation of the rod causes the rod to move axially within the cylinder in which it is mounted. The axial movement of the rods adjusts the electrical characteristics of the device.

The stability of the axial position of each of the rods is considerably enhanced by the configuration of the present invention. Further, since none of the rods extend beyond the housing there is no possibility for accidental contact with adjacent circuit components. Moreover, since assembly is performed on plate 32 prior to insertion into housing 10, manufacturing costs are reduced.

FIG. 3 shows a modification of the present invention. As shown herein, cylinder 34 can be utilized as a bobbin for coil 12. This modification further enhances the stability of the resonator unit against mechanical vibration and simplifies the manufacturing and assembling processes without adversely affecting the ease of adjustment of the rod within the cylinder.

A preferred embodiment and a modification thereof have been specifically disclosed herein for purposes of illustration. It is apparent that many variations and modifications may be made upon the specific structures disclosed herein. It is intended to cover all of these variations and modifications which fall within the scope of this invention and as defined by the appended claims.

I claim:

1. A double-tuned circuit device comprising a housing, an input lead and an output lead, a base plate having a conductive surface and adapted to be received within said housing, a pair of resonator units each of which comprises a helical coil having a first end and a second end with a tap therebetween, an insulating cylinder situated within said coil and mounted on said base and a rod movably received within said cylinder, said tap of each of said units being connected to a different one of said leads, said first ends of each of said coils being connected to said conductive surface and means for adjusting the electromagnetic coupling coefficient of said units, said means comprising a third insulating cylinder mounted on said base between said units and a third rod movably received therein.

2. The device according to claim 1 wherein said housing has a plurality of access holes therein, one of said access holes being aligned with each of said rods such that a tool may be inserted through said hole to move said rod relative to the cylinder into which it is received.

3. The device according to claim 1 wherein said cylinders are internally threaded and said rods are externally threaded such that said rods are axially movable relative to the respective cylinders by rotation thereof.

4. The device according to claim 1 wherein said coils and said rods are completely received within said housing.

* * * * *